The University of Mataram
FACULTY OF MEDICINE
Ethical Committee for Medical Research
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INDONESIA

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To Rohadi MD
Faculty of Medicine, the University of Mataram

Decision Issued from the meeting

Since research under the topic **"Characteristics and clinical outcome of traumatic brain injury in Lombok, Indonesia"** that has been submitted to the Ethical Committee for Medical Research by Rohadi Muhammad Rosyidi, Bambang Priyanto, Ni Komang Putri Laraswati, Andi Asadul Islam, Mochammad Hatta, Agussalim Bukhari, Muhammad Kamil, D.P. Wisnu Wardhana, is in full conformity with the relevant provisions of the International Ethical Recommendations for biomedical researches involving human beings, hereby, we grant an ethical permission for conducting above-mentioned research.

Sincerely,

dr. Arfi Syamsun, Sp.KF., M.Si.Med
Chairman, Ethical Committee for Medical Research
Faculty of Medicine, the University of Mataram
Mataram, INDONESIA

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Research Paper

Characteristics and clinical outcome of traumatic brain injury in Lombok, Indonesia

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ABSTRACT

Background: Traumatic brain injury (TBI) has risen sharply, mainly due to increased use of motorized vehicles in countries with low and middle income. Traffic accidents are the main cause of TBI (60%) followed by falls (20%–25%) and violence (10%). Computed tomography (CT) is recommended for initial assessment in emergency services. Not only provides information and diagnosis to identify surgical needs, but also helps in evaluating patients and outcomes.
Method: A retrospective study conducted using medical record data of neurosurgery patients who met the inclusion criteria in West Nusa Tenggara General Hospital in 2015 until 2017. The sample size is determined by consecutive sampling method.
Result: Sample size was 209 patients. Male patients more common than female (78.95%). The highest age group at 21–30 years (21.53%) with average age was 31.66 years old. The initial median GCS was 10 points. The most common cause was motor vehicle accidents (MVA) with 176 cases (84.21%). The highest mortality rate was found in the severe brain injury group with 31 patients (14.83%). Average duration of treatment were 7.58 days.
Conclusion: There was a significant relationship between age, initial GCS value, mortality rate, and length of stay for TBI patients with outcome predictions based on CT Marshall classification.

1. Background

Traumatic brain injury (TBI) is defined as traumatic skull structure with changes in cerebral physiology as a result of external forces in the form of mechanical, chemical, electrical or thermal heating. Traumatic brain injury is a major cause of mortality and morbidity in patients in the age between 18 and 45 years. TBI is a very influential public health and socioeconomic problem throughout the world. This is a major cause of death and disability among young individuals in developed countries. In the world, the incidence of TBI has risen sharply, mainly due to increased use of motorized vehicles in countries with low and middle income. Motor vehicle accidents (MVA) are the main cause (60%) of TBI followed by falls (20% -25%) and violence (10%) [1,2].

The overall incidence rate of TBI in the United States in 2002–2006 was 579 per 100,000 people, or about 1.7 million cases per year. TBI hospitalization rates in the US were 93.8 per 100,000 people. In a meta-analysis that included data from the 1990s and 2000s, TBI hospitalization rates in Europe were calculated to be 235 per 100,000 people. The incidence rate of TBI in developing countries is generally higher (for example, India is 160 per 100,000 people and Asia is 344 per 100,000) than developed countries and is predicted to surpass many diseases as a major cause of death and disability by 2030. While in Indonesia, From the data of brain injury in Dr.Sutomo General Hospital for 5 years from 2009 to 2013, the average number of brain injury sufferers was 1178 cases per year, with mortality rates ranging from 6.171% to 11.22%. This figure is higher than the international standard which ranges from 3 to 8%. Based on the severity, the mortality of severe brain injury patients ranged from 25.13% to 37.14%. This figure

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is relatively high compared to the literature, which is 22% [1,3,4].

Indonesia is a densely populated lower middle-income country, with a population of 250 million people. West Nusa Tenggara is a province of Indonesia. It comprises the western portion of the Lesser Sunda Islands, with the exception of Bali which is its own province. Mataram, on Lombok, is the capital and largest city of the province. The 2010 census recorded the population at 4,496,855; the latest estimate (for January 2014) is 4,702,389. The province's area is 19,708.79 km^2. The two largest islands in the province are Lombok in the west and the larger Sumbawa island in the east, with only a few medical services and hospitals that have Neurosurgery facilities, there are five hospitals that have neurosurgery services, 1 government hospital and 4 private hospitals with two neurosurgeons in West Nusa Tenggara Province. In this densely populated region, the number of people using cars and motorbikes has increased considerably in recent years, contributing to an increasing number of patients with TBI being treated in the region's hospitals. Despite the increase in TBI in the region, there has been a lack of data on the related burden and epidemiology of TBI in Indonesia. Understanding the circumstances that lead to TBI and describing the characteristics of cases of TBI are key to laying the foundations for interventions made in the interest of public health and preventive medicine to reduce this burden, especially in rural and remote areas. This study aims to fulfill this goal through the analysis of the characteristics of patients with TBI. The other purpose of this study is to identify its relationship with computed tomography (CT) patterns based on Marshall classification as outcome prediction factor.

TBI classification is needed to make an accurate diagnosis and predict outcomes. In clinical practice, the severity of TBI is generally classified as severe, moderate or mild according to the level of consciousness measured using the Glasgow Coma Scale (GCS). Most patients with severe TBI are unconscious, intubated, anesthetized and ventilated. This makes the clinical evaluation of the severity of intracranial injury with GCS less reliable. Thus, the use of CT scans that correlate with intracranial pressure can be useful variables for clinical evaluation that can provide information about predictive outcomes by determining the classification of TBI based on morphological criteria. One method for predicting outcomes based on CT scan results is to use the Marshall classification consisting of six classification groups [5,6]. (Table 1). Classification of CT III and IV is related primarily to morality, while the classification of CT I or II is more often associated with favorable outcomes.

2. Methods

Retrospective data was collected from trauma patients between January 2015 and December 2017. Medical record data of neurosurgical patients who met the inclusion and exclusion criteria in West Nusa Tenggara Provience General Hospital were used for the analysis. The sample size was determined by method consecutive sampling. The inclusion criteria in this study included: head trauma patients due to blunt or sharp trauma with a diagnosis of mild brain injury (GCS 15-14), moderate brain injury (GCS 13-9), and severe brain injury (GCS score ≤ 8) with male and female of all ages, accompanied by CT scans on each patient's medical record. Whereas, the exclusion criteria in this study were head trauma patients with diagnoses not brain injury, and or medical records of patients who were not equipped with the results of the CT scan of the patient. 209 samples was obtained to this study.

Data were collected by recording important information in the patient's medical record. Data recorded included: name, medical record number, age, sex, causes of trauma (MVA and fall), diagnosis, length of stay, mortality (survive or dead), GCS at the admission, the final GCS (recorded after patient recovered/died), and the CT scan results (grouped based on the Marshall classification). Data processing and analysis is done using SPSS version 21. Data is presented in tables and diagrams with percentages for categorical data, mean for continuous data, and median for ordinal data. Bivariate statistical analysis was performed using Pearson correlation test contingency analysis. Significant statistics were taken as a 2-tailed p value of 0.05 or less.

Table 2
Demographics of patients with TBI.

		Road traffic injury		Fall (%)	Total (%)
		Car (%)	Motorcycle (%)		
Sex	Female	8 (33,33)	30 (20)	6 (17,14)	44 (21,05)
	Male	16 (66,67)	120 (80)	29 (82,86)	165 (78,95)
	Total N(%)	24 (100)	150 (100)	35 (100)	209 (100)

3. Results and discussion

In 209 samples, male were more likely to experience brain injury than female, there were 165 (78.95%) male patients and 44 (21.05%) female patients in total. Motorcycle is the most common cause by 150 cases (71%) (Table 2).

According to the data shown in the Image 1, it can be concluded that traumatic brain injury patients most at age 11–30 years. This is relatively similar to the statistic of traumatic brain injury in the United States, which states the age group with the highest risk is group of 15–19 years [11].

Image 2 shows the number of patients with traumatic brain injury based on the causes of trauma. In 209 study samples obtained 174 patients (83.25%) got MVA with 23 patients (11.00%) in mild brain injury group, 75 patients (35.89%) moderate brain injury, and 76 patients (36.36%) severe brain injury. While there were 35 patients (16.75%) with fall mechanism, including 9 patients (4.31%) mild brain injury, 15 patients (7.18%) moderate brain injury, and 11 patients (5.26%) severe brain injury. Based on the data presented in the table above, motor vehicle accidents were the leading cause of traumatic brain injury, followed by injurious falls. A similar thing was obtained in research conducted by Saini et al. (2012) and Rohadi M. Rosyidi et al. (2019), where the majority causes of trauma was motor vehicle accident (83.6%), while 14% was fall [12,13].

Image 3 shows the number of patients with traumatic brain injury based on the mortality rate, there were 176 patients (84.21%) alive and 33 patients (15.79%) died. For the mild brain injury group, 32 patients (15.31%) survived and no patients died. In the moderate brain injury group, 88 patients (42,11%) survived and 2 patients (0.96%) died,

Table 1
CT Marshall classification.

Classification	Criteria
Diffuse Injury I	No visible intracranial pathology seen on CT scan
Diffuese Injury II	Cisterns are present with mid-line shift 0–5 mm and/or lesion densities present; no high or mixed density lesion > 25 cc may include bone fragments and foreign bodies
Diffuse Injury III	Cisterns compressed or absent with mid-line shift 0–5 mm; no high or mixed density lesion > 25 mm
Diffuse Injury IV	Mid-line shift > 5 mm; no high or mixed density lesion > 25 cc
Evacuated Mass Lesion(V)	Any lesion surgically evacuated
Non Evacuated Mass Lesion(VI)	High or mixed density lesion > 25 cc; not surgically evacuated

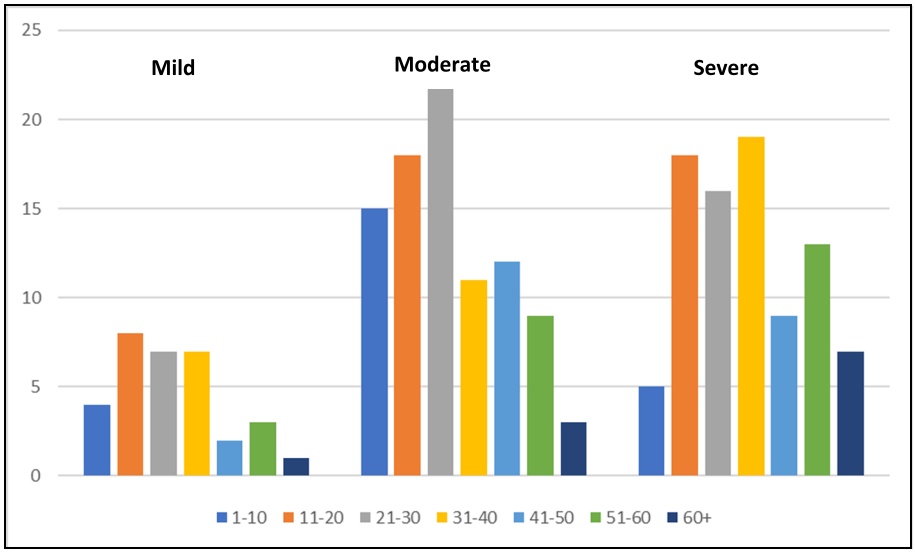

Image 1. The number of patients with traumatic brain injury based on age.

while in the severe brain injury group 56 patients (26.79%) survived and 31 patients (14.83%) died. In a study conducted by Rawis et al. (2016) obtained mortality rates of 18 people (45.0%) in the severe brain injury group and 7 people (17.5%) in the moderate brain injury group [11].

Image 4 shows outcome in traumatic brain injury patients based on CT scan results that have been grouped according to Marshall classification. In the mild brain injury group, all patients as many as 32 patients (15.31%) had a good outcome. In the moderate brain injury group, 50 patients (23.92%) had good outcomes and 40 patients (19.14%) had poor outcomes. While the severe brain injury group, 69 patients (33.01%) had poor outcomes and 18 patients (8.61%) with good outcomes.

Table 3 shows the Glasgow Outcome Scale in 209 study samples as outcomes in TBI patients, which 33 (15.79%) patients died, 2 (0.96%) patients with vegetative state, 18 (8.61%) patients with severe disability, 23 (11%) patients with moderate disability, and 133 (63.64%) patients with good recovery or no disability. In addition to GOS as one form of outcome assesment in TBI patients, there is a modified Rankin Scale (mRS) which can also be used to assess outcomes in TBI patient [9,10] (Table 4).

Table 5 shows the characteristics of TBI patients and its relationship with the CT scan results according to the Marshall classification. From the results of this study obtained 100 patients who had good outcomes and 109 patients with poor outcomes, based on the Marshall CT classification. The average age of TBI patients was 31.66 years, and group of patients with good outcomes had an average age of 28.31 years, while 34.73 years in group with poor outcomes. The average age have a significant relationship with outcome ($p = 0.009$). Age is a factor that influences mortality and morbidity, where increasing age will improve poor outcomes, especially at the age of > 40 years [7,8,15,16].

The percentage of male patients were 78.95%, which 47.27% in group with good outcomes and 52.73% in poor outcome group. There was no relationship between sex and outcome ($p = 0.794$) in the results of this study. Traumatic brain injury is more common in male than female, because male activities tend to be more outside, but there is no relationship between sexes and outcomes. Several studies have shown that good outcomes in female are associated with a neuroprotective effect of progesterone [7,8].

The initial median GCS of TBI patients was 10 points, which 12 points (5–15) in good outcome group and 8 points (3–13) in poor outcome group. The value of GCS has a significant relationship with outcome ($p < 0.001$). There is strong evidence for the prognostic value of GCS early on admission to hospital, and lower initial GCS associated with poor outcomes. A similar thing was obtained in research conducted by Grigorakos et al. [11], where patient with GCS of 3–4 had

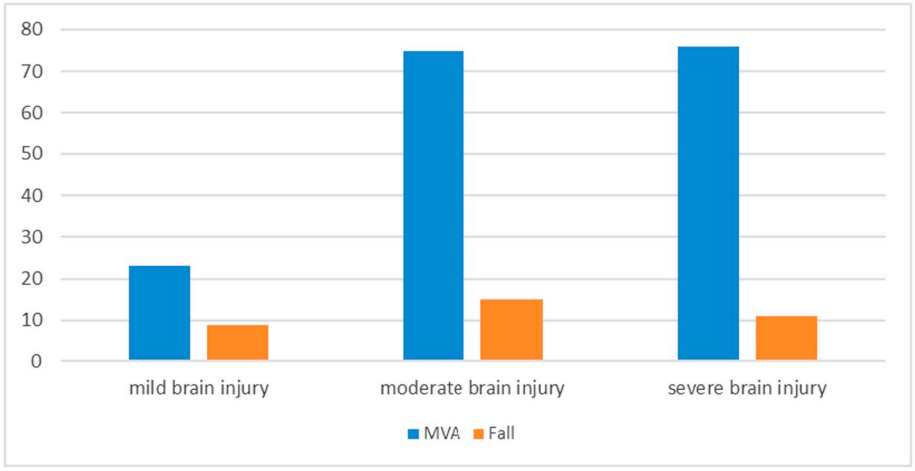

Image 2. The number of patients with traumatic brain injury based on the causes of trauma.

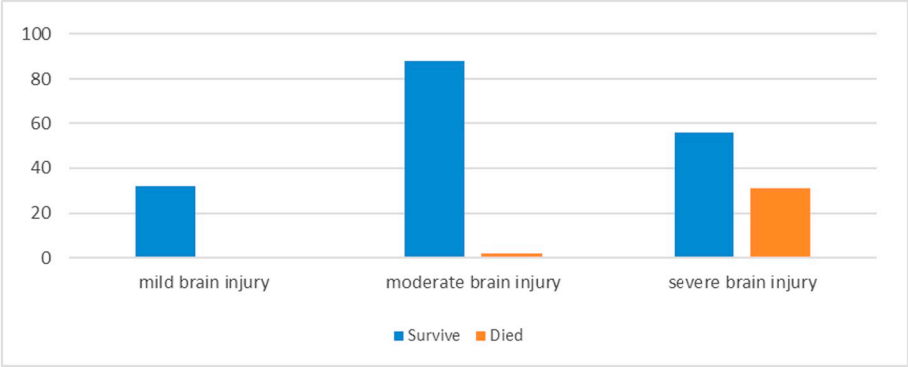

Image 3. The number of patients with traumatic brain injury based on mortality rate.

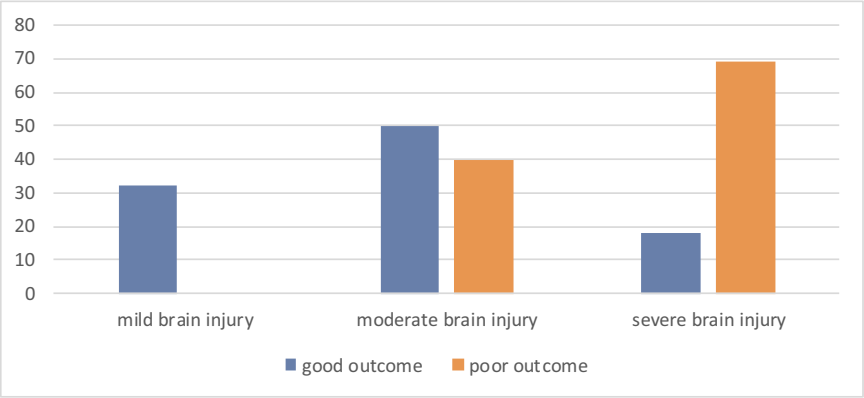

Image 4. Outcome in traumatic brain injury patients based on CT scan according to Marshall classification.

Table 3
Outcome in traumatic brain injury patients based on GOS.

Category	Classification	N (%)
1	dead	33 (15.79)
2	vegetative state	2 (0.96)
3	severe disability	18 (8.61)
4	moderate disability	23 (11)
5	no disability	133 (63.64)
	Total N (%)	209 (100)

Table 4
Outcome in traumatic brain injury patients based on mRS.

Category	Classification	N (%)
0	No symptoms	29 (13,88)
1	No significant disability	110 (52,63)
2	Slight disability	16 (7,66)
3	Moderate disability	1 (0,48)
4	Moderately severe disability	17 (8,13)
5	Severe disability	3 (1,43)
6	Dead	33 (15,79)
	Total N (%)	209 (100)

54,96% mortality that means poor outcomes. The cause of trauma in patients was 174 cases of motor vehicle accidents and 35 cases fell. In the good outcome group were obtained 83 cases of MVA and 17 cases fell, while in the group of patients with worse outcomes there were 91 cases of MVA and 18 cases. The cause of trauma in this study did not have a significant relationship with outcome ($p = 0.926$). Motor vehicle accidents are the most common cause in cases of severe brain injury. The increasing number of vehicles on the road and the increasing mobility of the population with a level of security such as the low use of

Table 5
Characteristics of TBI patients and its relationship with CT scan results according to Marshall classification.

Characteristics	All patients with TBI	Good outcome[a]	Poor outcome[b]	p pearson value
No. of patients (N)	209	100	109	
Mean age(years)	31.66	28.31	34.73	0.009[†]
Male (%)	78.95	47.27	52.73	0.749
Female (%)	21,05	50,00	50,00	
Median of early GCS	10	12 (5–15)	8 (3 – 13)	< 0.001[†]
Cause of trauma				
MVA (N)	174	83	91	0,926
Fall (N)	35	17	18	
Mortality rate				< 0.001[†]
Died (N)	33	4	29	
Survive (N)	176	96	80	
Mean duration of treatment (days)	7.58	5.39	9.60	< 0.001[†]

[a] Marshall I,II, and V with focal lesion of EDH.
[b] Marshall III, IV, and V with focal lesions of SDH, ICH, SAH.
[†] $p < 0,05$.

seat belts and helmets can cause increased cases of brain injury due to traffic accidents [7,14].

The number of patients who died in good outcome group was 4 people, while in the worse outcome group there were 29 people. There is a significant relationship between mortality rates with outcome ($p < 0.001$). Significant values related to mortality rate and outcome were also obtained in the study conducted by Wong et al. ($p = 0.001$). Average duration of treatment in TBI patients ranging from 7.58 days, while average duration of treatment in good outcome group were 5.39 days and 9.60 days in poor outcome group. ($p < 0.001$).

Logistic regression analysis was conducted to assess factors

Table 6
Bivariate and multivariate logistic regression with outcome patients with TBI.

Covariates	Bivariate association				Multivariate association			
	Odds ratio	95% confidence interval		*P* value	Odds ratio	95% confidence interval		*P* value
Sex	0.469**	0.156	1.413	0.179	0.448	0.142	1.411	0.170
Age	8.700*	2.935	25.790	0.000	8.881	2.978	26.485	0.000
Early GCS	8.700*	2.935	25.790	0.000	8.881	2.978	26.485	0.000
Cause of trauma	0.450**	0.129	1.566	0.209	0.414	0.114	1.508	0.181
duration of treatment	8.700*	2.935	25.790	0.000	8.881	2.978	26.485	0.000
Marshall CT	8.700*	2.935	25.790	0.000	8.881	2.978	26.485	0.000

* $P < 0{,}001$.
** $P > 0{,}05$.

associated with outcomes of TBIs among patients admitted to the Hospital (Table 6). In the bivariate and multivariate logistic regression analysis, age, patient GCS at admission, duration of treatment in hospital, and Marshall CT classification statistically had a significant relationship to the outcome of TBI patients ($P < 0.05$ with OR 8.700). While gender ($P > 0.05$ with OR 0.469) and causes of trauma ($P > 0.05$ with OR 0.450) didn't have a significant relationship to the outcome of TBI patients.

4. Conclusion

Thus the characteristics of brain injury patients in this study that had a significant predictive outcome based on the Marshall CT classification were age, initial GCS score, mortality rate, and length of stay. This study resume that the characteristic of TBI patients in the rural area of developing country shows the same image as other place. Further study should be established to represent bigger image of it, and finally can help to decrease the burden causing by TBI.

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References

[1] Winn H. Richard, Youmans. Traumatic brain injury, Youmans Neurological Surgery, 6th edition, vol. 4, Elsevier, Philadelphia, 2011, pp. 3267–3270.
[2] K.C. Wong George, H.H. Yeung Janice, A. Graham Colin, Xian-Lun Zhu, et al., Neurological outcome in patients with traumatic brain injury and its relationship with computed tomography patterns of traumatic subarachnoid hemorrhage, J. Neurosurg 114 (2011) 1510–1515. Available from: https://www.ncbi.nlm.nih.gov/pubmed/21332291.
[3] Faul Mark, Coronado Victor, Epidemiology of traumaic brain injury, in: J. Grahman, A.M. Salazar (Eds.), Handbook of Clinical Neurology, 3rd series, vol. 127, Elsevier, USA, 2015, pp. 1–13. Available from: https://www.elsevier.com/books/traumatic-brain-injury-part-i/grafman/978-0-444-52892-6.
[4] Wahyudi Joni, Suryaningtyas Wihasto, Susilo Rahadia Indarto, Faris Muhammad, et al., Guidelines for the Management of Brain Injury, 2nd ed., Medical Faculty of Airlangga University, Surabaya, 2014, pp. 15–17.
[5] Cristian Rincon-Guio, M. Gomez Ana, D. Charry Jose, The Role of Computed Tomography as a Prognostic Tool in Traumatic Brain Trauma, vol. 9, (2017) Issue 6. Available from: https://www.openaccessjournals.com/articles/the-role-of-computed-tomography-as-a-prognostic-tool-in-traumatic-brain-trauma-12278.html.
[6] Saini Singh Navdeep, Rampal Vikas, Dewan Yashbir, S. Grewal Sarvpreet, Factors predicting outcome in patients with severe head injury: multivariate analysis, Indian J. Neurotrauma 9 (1) (2012) 45–48. Available from: https://www.sciencedirect.com/science/article/pii/S097305081200010X.
[7] Kulesza Bartlomiej., Nogalski Adam., Kulesza Tomasz., Prystupa Andrzej. Prognostic Factors in Traumatic Brain Injury and Their Association With Outcome. 2015. Vol vol. 9. Available from: http://www.jpccr.eu/Prognostic-factors-in-traumatic-brain-injury-and-their-association-with-outcome,71517,0,2.html.
[8] Verma Saurabh Kumar, Guota Vijay Kumar, Rappai Tony Joseph, et al., Early Indicators of Prognosis in Traumatic Brain Injury and Their Association With Outcome, vol. Volume 16, (2017) Issue 6 Ver. IV. Available from http://www.iosrjournals.org/iosr-jdms/papers/Vol16-issue6/Version-4/I1606044448.pdf.
[9] Miller Kelly J., Schwab Karen A., and Warden Deborah L. Predictive value of an early Glasgow Outcome Scale score: 15-month score changes. J. Neurosurg. 103:239–245. Available from: https://thejns.org/view/journals/j-neurosurg/103/2/article-p239.xml.
[10] Banks Jamie L and Marotta Charles A. Outcomes Validity and Reliability of the Modified Rankin Scale Implications for Stroke Clinical Trials. A Literature Review and Synthesis. Vol vol. 38, No 3. Available from: https://www.ahajournals.org/doi/full/10.1161/01.str.0000258355.23810.c6.
[11] Grigorakos Leonidas, Akexopoulou Anastasia, Tzortzopoupou Katerina, et al., Predictors of outcome in patients with severe traumatic brain injury, J. Neurosci. Clin. Res. 1 (2016) Issue 1. Available from: https://www.scitechnol.com/peer-review/predictors-of-outcome-in-patients-with-severe-traumatic-brain-injury-4oea.php?article_id=5494.
[12] Rohadi M. Rosyidi, Bambang Priyanto, Asra Al Fauzi, Agung Budi Sutiono, Toward zero mortality in acute epidural hematoma: a review in 268 cases problems and challenges in the developing country, Interdiscip. Neurosurg. 17 (2019) 12–18. Available from: https://www.sciencedirect.com/science/article/pii/S2214751918302871.
[13] L. Rawis Maria, Ch. Lalenoh Diana, T. Kumaat Lucky, Profile of Patients With Moderate and Severe Head Injuries Who Are Admitted to the ICU and HCU, Vol 4, No 2 (2016) Available from: https://ejournal.unsrat.ac.id/index.php/eclinic/article/view/14481.
[14] Saini Navdeep Singh, Rampal Vikas, Dewan Yashbir, et al., Factor predicting outcome in patients with severe head injury: multivariate analysis, Indian J. Neurotrauma (2012) 45–48. Available from: https://www.sciencedirect.com/science/article/pii/S097305081200010X.
[15] Marappan Kodeeswaran, Prabhu M., K Balasubramani, Raj Sherina Paul. Factors influencing outcome in head injury patients with Glasgow coma scale < 8. 2017. Volume 14, Issue 4, P 207–211. Available from: http://www.apollomedicine.org/article.asp?issn=0976-0016;year=2017;volume=14;issue=4;spage=207;epage=211;aulast=Marappan.
[16] M. Chesnut Randall, Ghajar Jamshid, I.R. Maas Andrew, et al., Early Indicators of Prognosis in Severe Traumatic Brain Injury, Available from, 2000. https://www.researchgate.net/publication/294632438_Part_2_Early_indicators_of_prognosis_in_severe_traumatic_brain_injury.